A Historical Perspective of U.S. Climate Divisions

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ABSTRACT

The history of climatic divisions in the contiguous United States has been pieced together from fragmentary documentation. Each of the 48 contiguous states has been subdivided into climatic divisions. Divisional boundaries are now standardized, and a set of climatic variables for time-invariant divisional boundaries has been compiled for the period of record beginning in 1895. This paper documents the origins of climatic divisions, the computational methodology of an area-invariant divisional dataset maintained by the National Climatic Data Center, and the strengths and weaknesses of divisional data.

1. Introduction

Each of the 48 contiguous U.S. states has been subdivided into as many as 10 climatic divisions, depending upon the size of the state. The divisional boundaries are structured such that they often coincide with county boundaries and always cover the total area of the state. There are a total of 344 divisions in the contiguous United States. A divisional dataset has been compiled that consists of year–monthly means (means of daily data in a given year and month) of temperature and water-equivalent precipitation since 1895 for each of the divisions in the contiguous United States. Drought and prolonged wet weather event (moisture anomaly) statistics and heating/cooling degree days have been derived from the basic data. These data are used operationally by the National Climatic Data Center (NCDC) to produce the monthly *Climate Variations Bulletin.* Near-real-time updates of station data from the National Weather Service's (NWS) Climate Prediction Center (CPC) provide estimates of the near-real-time divisional data. Routine final updates are produced at NCDC from the 5000+ station National Weather Service Cooperative Daily Temperature–Precipitation Station network. Near-real-time weekly climatic division data (reported by NWS field offices) are also used operationally by the CPC to compute drought indexes published in the *Weekly Weather and Crop Bulletin* (Heddinghaus and LeComte 1992). The indexes are updated with NCDC-derived data when available.

Divisional data are used to assess large-scale climatic features or anomalies with respect to a long period or century-scale perspective. These assessments often encompass a variety of climatic applications. For example, the divisional data have been used by Diaz and Quayle (1978) in an assessment of the severity of the 1976/77 winter, by Guttman (1983) in an analysis of the combined effects of weather and population on energy demand, and by Soule (1992) in a study of regional differences in the persistence of average weather. This paper documents the origins of climatic divisions, the computational methodology of an area-invariant divisional dataset for the contiguous United States that is maintained by the NCDC, and the strengths and weaknesses of the divisional data.

Climatic divisions have also been developed for Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and Pacific trust territories. These divisions generally have data with lengths of record that are shorter than for the contiguous U.S. divisions, and so they are not described in this paper. These data are available, however, from NCDC.

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2. Origins

Prior to the creation of the U.S. Weather Bureau in 1890, climatological data were collected by the meteorological division of the U.S. Army's Signal Corps (Hughes 1980) and published by station in the *Monthly Weather Review*. The practice was continued under the auspices of the Weather Bureau's Climate and Crop Service. In 1906, the Weather Bureau reorganized its climatology activities and formed the Climatological Service (U.S. Department of Agriculture, Weather Bureau 1906). The Climatological Service was organized to collect and publish information regarding the climate and prevailing weather conditions of the country. An administrative unit called a "section" was established in each state or group of states. A section director was charged with the responsibilities of preparing all climatological publications and reports, supervising all cooperative observers, and establishing cooperative observation stations for his section. Monthly and annual summaries of meteorological data were sent to the central office of the Weather Bureau for consolidation and publication by section in the *Monthly Weather Review*. Data were published by station within states. For some states, especially in the east, the stations were further subdivided into geographic regions.

In 1908 the name of the Climatological Service was changed to the Climatological Division (U.S. Department of Agriculture, Weather Bureau 1908). The Division charge was similar to that of the Service and included all matters relating to climatology. The specific responsibility of preparing meteorological tabular data for *Monthly Weather Review* and other publications remained intact under the reorganization.

It was also recognized in 1908 that water issues in the west (Washington, Montana, North Dakota, South Dakota, Nebraska, Wyoming, Idaho, Oregon, California, Utah, Nevada, Colorado, Arizona, and New Mexico) were important to the country's economy. A cooperative effort was agreed upon between the Weather Bureau, the Bureau of Reclamation, the Forest Service, the Bureau of Plant Industry, and the Geological Survey to study water resources (water supply from snow and rain at high elevations, evaporation from lakes and storage basins, influence of forests on water conservation, and meteorological conditions necessary for plant growth in irrigated deserts) in the semiarid region of the west. Implementation of the Weather Bureau part of the agreement was placed under the direction of the Climatological Division (U.S. Department of Agriculture, Weather Bureau 1908).

Because of the recognition that climatological data were being used not only by those interested in agriculture and transportation, but also by those interested in power development and water resources, it was decided in 1909 to group climatic data according to natural topographic districts (U.S. Department of Agriculture, Weather Bureau 1909). The contiguous United States was divided into 12 climatological districts that conformed to the 12 principal drainage basins. The boundaries of the districts, which are coincident with the boundaries of the drainage basins, are depicted in Fig. 1. This scheme was thought to afford the best system of territorial units for the compilation and dissemination of climatological data for applications in agriculture, transportation, irrigation, forestry, and engineering. The publication of monthly climatic data and summaries by state was therefore discontinued in favor of publication by the new climatological districts. These 12 districts are the first climatic divisions to be defined by criteria other than political boundaries. They were abandoned in 1914, however, because of the difficulty of promptly disseminating the district climatological information to users in a large area.

One hundred and six *climatology* sections, in contrast to the administrative sections discussed above, were established in 1912 for the publication of summaries of data through about 1910 (U.S. Department of Agriculture, Weather Bureau 1912). The boundaries for these climatology sections (Fig. 2) were established for the purpose of summarizing and publishing data in appropriate geographic detail for economical distribution; they were based primarily on mailing practicality rather than on homogeneous climate considerations. These sections were subsequently updated in 1926 and 1930 (the section numbers and a few of the boundaries changed for the 1930 revision) and remained in use until the 1940s.

Internal Weather Bureau memoranda in the 1940s indicate that climatic data for a state were, for reporting purposes, divided into either crop districts or drainage basins. It appears (without verification) that the directors of the administrative sections made the boundary decisions based on local user needs, the relationship between climate and local agriculture or water needs, and/or communication avenues. There was, however, no standardized system of defining climatic divisions.

In 1949, according to an internal U.S. Weather Bureau memorandum (U.S. Department of Commerce,

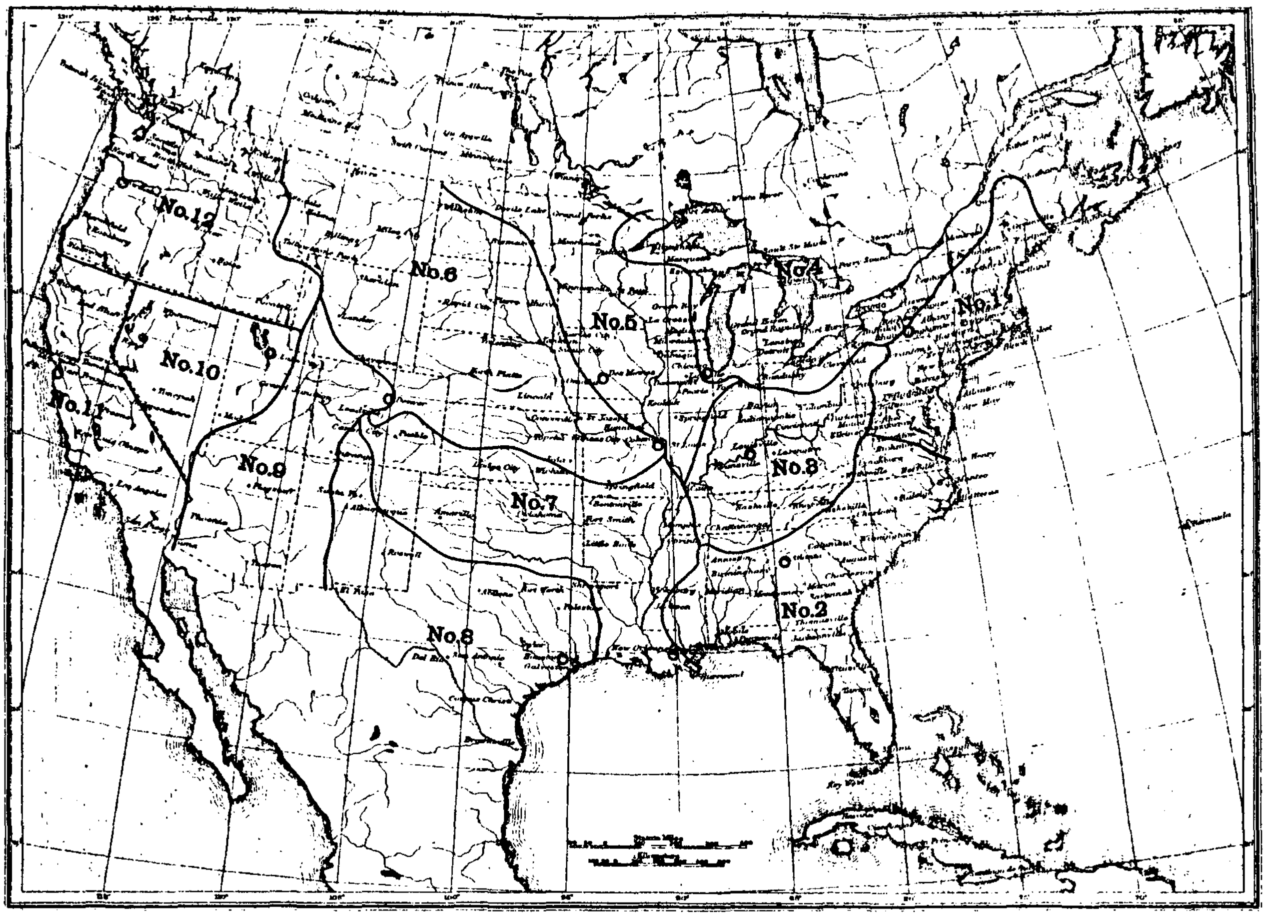


FIG. 1. Twelve climatological districts, 1909–13.

Weather Bureau 1949), a number of directors of the administrative sections indicated the need for partitioning their sections into divisions that would be appropriate for weighting (exactly what "appropriate" entailed was not documented), joint publication of statistics, convenience in data handling, etc. After careful study, it was concluded that the best partitioning would result from the adoption of the U.S. Department of Agriculture Bureau of Agricultural Economics Crop Reporting Districts as divisions. The most significant reason for the decision was the relationship between crop type (one of the primary bases of the determination of crop reporting districts) and climatic classification.

In the mid-1950s, the state climatologists realigned some of the divisional boundaries to better suit their needs (U.S. Department of Commerce, Weather Bureau 1958). There were also some minor revisions in the early 1960s in conjunction with the computation of the 1931–60 climatic normals. In some cases the boundaries were defined as drainage basins (e.g., in western states where water resource issues are paramount) and may be relatively inhomogeneous for some climatic applications. In other cases they were made more climatically homogeneous, with respect to the relationship between climate and the dominant crops grown in the area. In many cases they were not changed at all. Figure 3 shows the current divisional boundaries. These divisions were used by the NCDC to compile a serially complete divisional dataset with invariant divisional boundaries covering the period from 1895 onward (data for some states are available prior to 1895).

Although data were sometimes organized by subdivisions of states in the *Monthly Weather Review* and *Climatological Data* bulletins (U.S. Department of Agriculture 1895–1940; U.S. Department of Commerce 1940–present) from the 1800s onward, there is no evidence that these areas were based on climate considerations. It appears that the rationale for organizing the data was based on geography, drainage basins, river districts, and/or forecast areas of responsibility. It was not until the 1950s that a standard national scheme, based partially on climate consider-

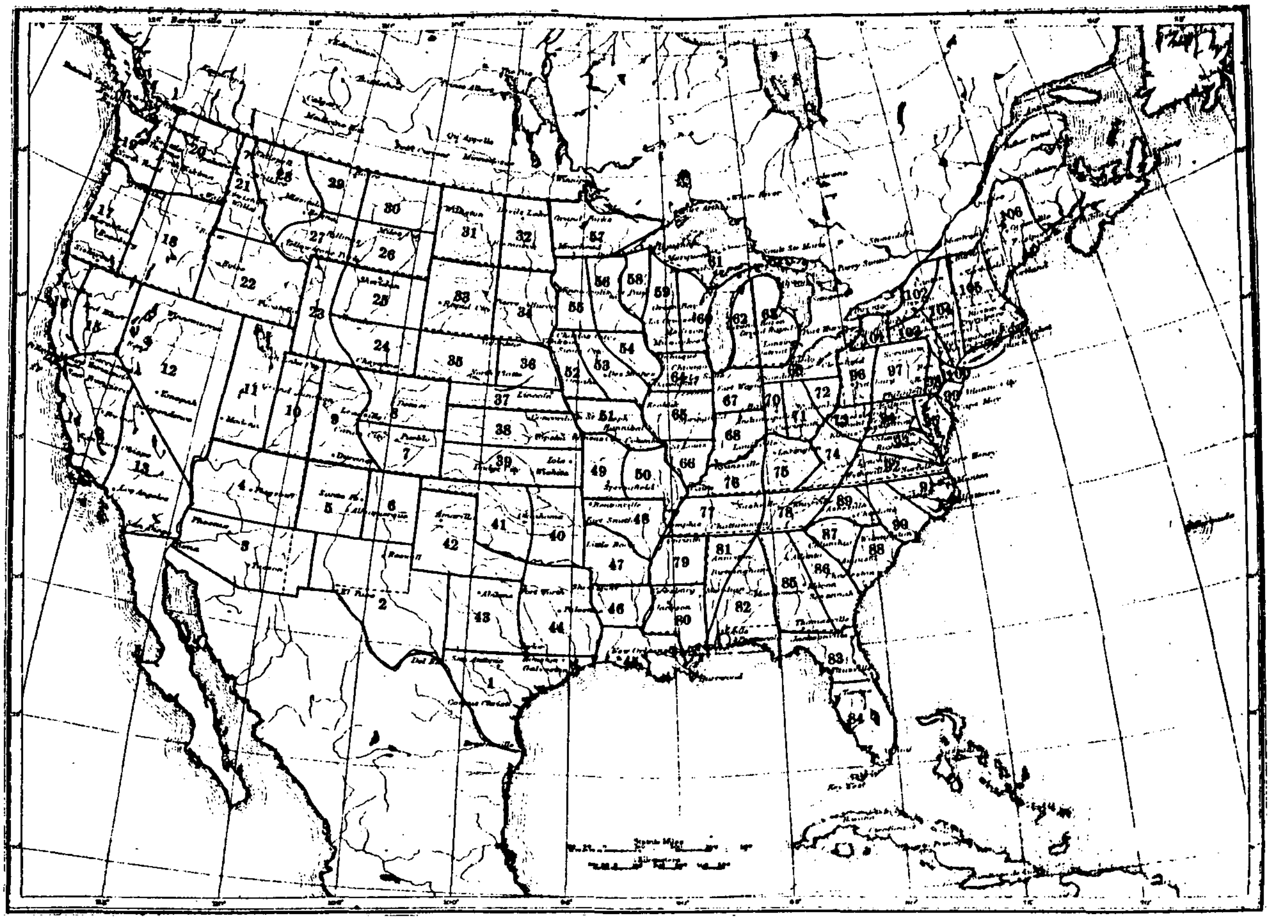


FIG. 2. One-hundred-six climatological sections, 1912.

ations, was implemented. A consistent, areally invariant, comprehensive century-scale dataset, based on the standard national divisional scheme, has become available only in the past decade.

3. Computational methodology

In their most basic form, divisional averages are simple unweighted arithmetic means of monthly data from all representative stations within a given division. "Representative" in this sense is defined as subjectively excluding stations that are not compatible with the general climatic characteristics of the division (e.g., mountain-top locations). In reality, computation of the entire suite of variables for all time-invariant divisions for every year and month since January 1895 was a complex undertaking and is described by Karl et al. (1983).

Stated summarily, the divisional temperature and precipitation data from 1931 to the present were calculated from station data as noted above. Prior to 1931, sufficient digital station data were not available for computation of divisional averages. However, statewide values had been computed for the late 1800s to 1948 (U.S. Dept. of Agriculture 1951) by simple averaging of the data from all available reporting stations within each state. Divisional data for 1895–1930 were derived from these U.S. Department of Agriculture (USDA) statewide averages via regression techniques. The regression equations relating each division to surrounding state averages were developed using an overlap period when both statewide and divisional data were available from homogeneous sources (Karl et al. 1983). The resulting temperature data were then adjusted for observation time bias, and other variables were derived from these data.

a. Temperature and precipitation

1) STATE CLIMATIC DIVISIONS

Since 1931 each monthly average temperature within a division has been calculated by giving equal weight to each representative station reporting temperature within the division. The number of stations within a division varies over time as stations open and close. By using many stations within a division to calculate averages, this potential source of bias is minimized. Nonetheless, for those divisions with complex terrain and few continuously operating stations, caution should be exercised, especially by those interested in small differences for applications such as climatic change.

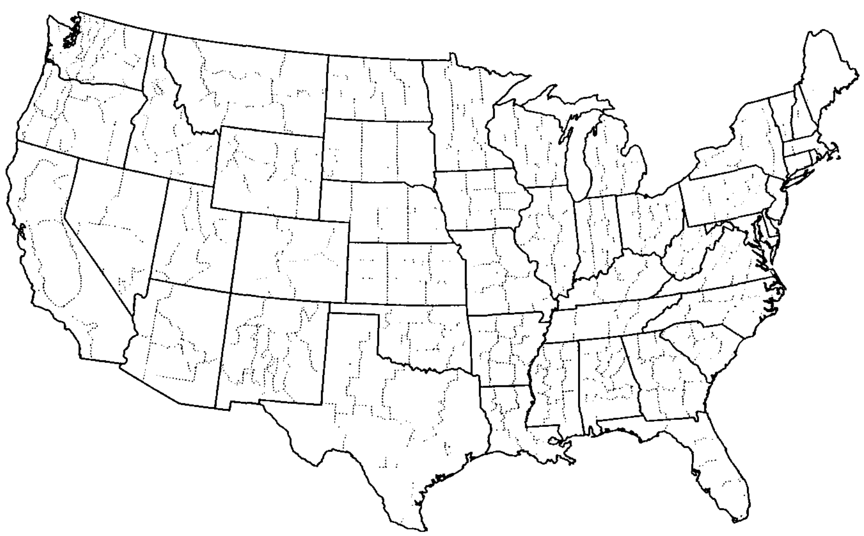


FIG. 3. A map of the 344 state climatic divisions in the contiguous United States.

Prior to 1931, divisional averages were calculated from state averages published by the USDA. Using data from 1931 through 1982, linear regression equations were developed whereby the divisional average temperature was predicted from the average temperature of the state, as well as surrounding states, containing that division. These regression equations were used to estimate the divisional temperatures prior to 1931 from the USDA state values. The correlation coefficients between the regression estimates and the actual divisional averages during the 1931–82 time period were mostly larger than 0.95, except during the summer season (especially along coastal areas and in the divisions where the United States borders Mexico or Canada) when the coefficients were usually above 0.90. The lowest correlation (0.51) from the set of over 4000 regression equations was in the Florida Keys climatic division during September.

The quasi-consistent changes in observation times since the early 1900s (from late afternoon to early morning) introduced a subtle bias (cooling) into the temperature record. The divisional temperature data have been adjusted for this using the method developed by Karl et al. (1986). Known changes in observation times, as documented in original station history records, were used to calculate adjustment factors for each year affected.

Divisional averages of precipitation were calculated in the same manner as divisional averages of temperature with one important exception—only those stations that reported *both temperature and precipitation* were used to calculate the divisional average precipitation. The total number of stations in a division that reports precipitation in any given year and month is often greater than the number used in this divisional dataset. The station network constraint, however, ensures that averages of temperature and precipitation are calculated from the same set of stations.

In the mid-1980s, the NCDC began routinely incorporating corrected and late station temperature and precipitation reports into the divisional dataset. The corrected and late station data for the period prior to the mid-1980s (for the contiguous 48 states) were incorporated into the historical dataset at that time.

2) STATEWIDE AVERAGES

Monthly averages of temperature and precipitation have been calculated for all 48 contiguous states dating back to the late nineteenth century. Except for the New England states and the early years of California data, the statewide averages in this dataset were calculated by areally weighting the divisional averages for the period 1931–present. For data prior to 1931, the statewide averages were estimated from data compiled by the U.S. Department of Agriculture (1951), which published state averages of precipitation and temperature from the late 1800s through 1948. The USDA statewide averages were obtained by equally weighting all available reporting stations within a state. The average monthly temperature and precipitation data as published by the USDA for the beginning of record to 1931 were adjusted to achieve homogeneity with the post-1930 state averages obtained from areally weighted divisional data.

For each month, the average difference in temperature (ratio for precipitation) was calculated for the overlapping period of 1931–48. These differences (ratios) were used to adjust the pre-1931 temperature (precipitation) data to achieve a quasi-homogeneous dataset from the beginning of record to 1982, compatible with the calculation procedures followed for the 1931–82 data. The correlation between the two datasets for both temperature and precipitation for each state and month was high (> 0.90) (Diaz and Quayle 1978).

In New England, the USDA (1951) combined the states of Maine, New Hampshire, and Vermont into northern New England, and Connecticut, Massachusetts, and Rhode Island into southern New England. The USDA data, therefore, did not include statewide values for these six New England states. For this reason it was necessary to digitize regional averages of temperature and precipitation for these states as they appeared in the publication *Climatological Data* (U.S. Department of Agriculture 1895–1930). These averages were then areally weighted to obtain state averages for 1895–1930.

In California, the earliest published (USDA 1951) data began in January 1897. For the years 1895 and 1896 monthly estimates of statewide averages of temperature and precipitation were obtained by constructing isopleth analyses of the monthly station data. Isopleths were subjectively (visually) interpolated and extrapolated to statewide averages.

In spite of the high correlation between the statewide average data derived from the state climatic divisions and the USDA's published data during the overlap period, there were still some unrealistically large serially correlated departures from normal, mainly for the temperature dataset during the early portion of the period of record in some of the mountainous western states (Arizona in particular). To determine the cause, geographical station network distributions were reviewed. During the early period of record, some of the western states had relatively few stations in sparsely settled areas of the state. For example, in January 1900 only 10% of the stations in Arizona were located north of the 35th parallel (approximately the northern half of the state), and well over half of the stations were located in the southeast quarter of the state (U.S. Department of Commerce 1958). As new stations were added in areas that previously had relatively few stations and thus had been given little weight in the state average (prior to 1931), an apparent change in climate was introduced into the time series.

To correct this problem, the temperature and precipitation datasets (prior to 1931) in the 11 western states from Montana to New Mexico and west to the Pacific Ocean were adjusted a second time (Karl et al. 1983). The mean difference of the statewide 3-month (January–March, April–June, . . .) average from the USDA published data (U_j) and another statewide 3-month average derived from a fixed number of stations (F_j) spatially distributed as evenly as possible across each state was calculated. This 3-month mean difference (D_j) is defined as

$$D_j = \left[\sum_{i=1}^{N} \left(U_{i,j} - F_{i,j} \right) \right] (N)^{-1}, \tag{1}$$

where $j = 1$ is January through March, $j = 2$ is April through June, etc., and N is the number of coincident years i prior to 1931 in the two datasets. The magnitude and sign of an adjustment factor A_{ij} is

$$A_{i,j} = D_j - \left(U_{i,j} - F_{i,j} \right), \tag{2}$$

and the final adjusted monthly (mo) statewide average $U'_{\mathrm{mo},i}$ is

$$U'_{\mathrm{mo},i} = U_{\mathrm{mo},i} + A_{i,j} \tag{3}$$

if

$$A_{i,j} > 0.25°\mathrm{F}, \text{ or if} \tag{4}$$

$$A_{i,j} > 0.25 \text{ in. and } U_{\mathrm{mo},i} > 0.25 \text{ in.} \tag{5}$$

If conditions (4) or (5) were not met, then no adjustment was applied. The threshold values in (4) and (5) were chosen based on subjective estimates of the year-to-year variability of D_j not associated with any linear trends as depicted in time series plots.

In each state where $U_{\mathrm{mo},i}$ extended farther back in time than $F_{\mathrm{mo},i}$, an average of the first 5 yr of coincident data were used to obtain the term ($U_{i,j} - F_{i,j}$) in (2), and subsequently the adjustment $A_{i,j}$ was applied to the remaining data ($U_{\mathrm{mo},i}$) when relational tests (4) and (5) were true. Therefore, during the early years of record when $U_{\mathrm{mo},i}$ data exist but $F_{\mathrm{mo},i}$ data do not exist, the statewide averages should be used with caution. The beginning dates of the fixed network for each of the 11 western states are listed below:

	Temperature	Precipitation
Arizona	1904	1897
California	1895	1895
Colorado	1903	1910
Idaho	1909	1904
Montana	1906	1905
Nevada	1913	1914
New Mexico	1900	1900
Oregon	1903	1897
Utah	1914	1905
Washington	none	1900
Wyoming	1905	1900

b. Heating and cooling degree days

Population-weighted heating and cooling degree days (base 65°F) have been calculated back to 1895 for each of the 48 contiguous states. Monthly averages of divisional temperatures were used to estimate the divisional total heating and cooling degree days for each month using a technique developed by Thom (1954a,b, 1966). The total number of degree days for each state was then computed by weighting each division by its total population as reported from the 1990 census (U.S. Department of Commerce, Bureau of the Census 1991). All degree day data for all years back to 1895 were recomputed using 1990 population weights so that past climatic conditions could be evaluated in light of contemporary population distributions.

c. Drought indexes

Four drought indexes have been calculated: Palmer's (1965) *Meteorological* Drought Severity Index (PDSI), *Hydrological* Drought Index (PHDI), Z index, and a modification of the PDSI (referred to here as PMDI). Qualitatively, the main difference between the PDSI, PHDI, and PMDI is in their treatment of the beginning and ending times of droughts or wet weather periods. During the maximum severity of a drought or wet period, these three indexes are identical. The PDSI is a meteorological drought index, and as a result it attempts to classify spells of weather. This means that once the weather begins to change to a new regime, regardless of soil moisture conditions, streamflow, or lake levels, etc., the index will respond rapidly and return to near-normal values. The PHDI is a hydrological drought index, and it should more closely reflect the soil moisture, streamflow, lake levels, etc. than the PDSI. Once the weather begins to establish a new regime, this index will respond slowly because it is more closely tied to the water storage.

The PDSI is a retrospective index because current values depend on future conditions. It is useful as a climatological indicator but not as the real-time index for making operational decisions. The PHDI can be used in real-time, but it is slow to respond to changing weather patterns. The PMDI is a compromise between the PDSI and the PHDI: it can be used in real-time, and it responds much more quickly to changing patterns than the PHDI. The Z index is a monthly standardized moisture anomaly index based on the month's water balance. It is a measure of short-term moisture conditions, computed independently of the conditions occurring in prior or subsequent months. It is important to note that all four Palmer indexes are insensitive to man-made droughts, such as drought created by large-scale changes in the local water usage. More detailed descriptions are given by Palmer (1965), Karl (1983, 1986), Alley (1984), Heddinghaus and Sabol (1991), Guttman (1991), and Guttman et al. (1992).

Calculation of the Palmer indexes requires input of sequential temperature and precipitation. The indexes were calculated using the monthly average temperature and precipitation from each of the state climatic divisions. For the first month in the time series, the drought indexes are assumed to be zero. As a result, caution should be used for the first few years of record because a drought or wet period could have been already established at the time the calculations began. The indexes are calibrated using data from the period 1931–90. Calibration is needed to establish what Palmer (1965) called "climatically appropriate for existing conditions" (CAFEC) norms for the intermediate model variables (potential evapotranspiration, runoff, precipitation, etc.). The CAFEC norms represent average soil moisture conditions during the calibration period.

4. Weaknesses

One weakness in the computation of divisional averages is that the divisional boundaries may not delineate areas of climatological homogeneity. The boundaries are defined mainly by drainage basins or major crops. In a lot of regions these boundaries do not relate to climate. An assertion of climatological homogeneity, however, depends not only on the climatic variable being averaged and its spatial pattern but also on what constitutes homogeneity. Temperature may be homogeneous with respect to statistical distributions over an area, but precipitation over the same area may be inhomogeneous with respect to statistical distributions. In contrast, both the temperature and precipitation may be homogeneous with respect to agricultural crops grown or livestock raised. Homogeneity depends on the climatic variables of interest, on what constitutes climate (the definition of climate), the controlling atmospheric physics, and the use of the data. It would be very difficult, if not impossible, to define homogeneous divisions for universal application.

An example of a division that is likely to be inhomogeneous for most applications is the Colorado Drainage Division. This division is located in the mountainous western one-third of the state and currently includes about 60 reporting sites that range in elevation from about 1500 to 3200 m. Some sites are in valleys, and others are near the tops of mountains. This variability of site exposure results in a wide range of precipitation and temperature within the division. Data from January 1989 illustrate this variability; monthly mean temperatures within the division ranged from −18° to −4°C, with an average of −9°C, and precipitation amounts ranged from 7 to 65 mm, with an average of 26 mm.

Another weakness is that the network of stations within a division is not constant. Averages are calculated for the stations that report a datum in any given month; the number and the location of stations has varied considerably over the period of record. Using the same Colorado division as an example, in 1913 there were less than 25 reporting stations compared to about 60 in 1989. If a division is homogeneous with respect to the climatic variable and data use of interest, then the weakness is mitigated. On the other hand, if complicating factors such as topography render the division inhomogeneous, then the changing network could result in misleading temporal comparisons.

A third weakness is that the regression estimates of the pre-1931 data generally exhibit reduced variance when compared to the post-1930 data. Inflated regression techniques were not used, and the variability of the data over the two time periods may not be homogeneous. Documentation of quantitative comparisons and of the details of the variance patterns before and after 1931 are no longer available. Documentation of any effort to analyze the residuals from the regression techniques is also not available. Therefore, a user of the data should be cautious if variance inhomogeneities are a concern.

5. Strengths

Considering the seemingly diverse station coverage and the varied terrain of some divisions, the data show remarkable coherence in space and time. Large-scale anomalies such as the droughts of the 1930s, 1950s, and 1980s, and the cold winters of the 1970s, are all faithfully depicted. The continuity in time and space, with no data point missing or grossly in error for the period since 1895, makes the dataset valuable for century-scale (or shorter) perspectives that require serially complete data. The sizes of the divisions allow construction of custom-tailored regions based on a variety of criteria approximating crop-growing belts, river drainage basins, electric power grids, numerical model grids, geopolitical regions, etc. Applications can also be data driven to delineate areas with specified anomalies or other characteristics. For example, the area with 1 April–1 May climatological freeze potential over 20% can be superimposed (in geographic information system fashion) over the area with climatically averaged growing degree days (of base 0°C) to show macroscale risk zones for certain types of fruit trees.

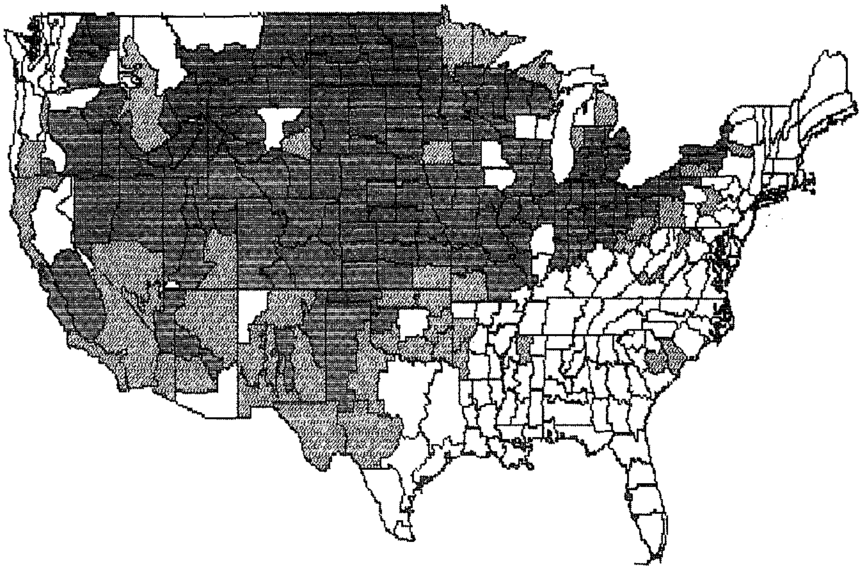
As examples of divisional data products, the PDSI that is mapped in Fig. 4 illustrates the geographical extent, intensity, and long-term perspective of the significant historical moisture anomalies that occurred in the contiguous United States during (a) the height of the Dust Bowl era in the 1930s, (b) the drought of 1988, and (c) the flood rains of 1993. Note that the spatial coherence appears to be quite reasonable. Figure 5, which portrays a time series of the percentage of the area of the contiguous United States that has experienced severe to extreme drought, and Fig. 6, which portrays a time series of growing season precipitation averaged across the primary corn and soybean agricultural region, illustrate the intensity of the two drought episodes shown in Fig. 4. Figure 6 also depicts the intensity of the 1993 floods.

6. Data availability

The NCDC routinely publishes monthly averages of temperature and precipitation for state climatic divisions in the publication *Climatological Data,* and statewide values of areally weighted monthly temperature and precipitation, and population-weighted heating and cooling degree days, in the publications *Historical Climatology Series 5-1* and *Historical Climatology Series 5-2 Monthly Updates.* Monthly period of record and 30-yr (1961–90) means of statewide values are published in the publications *Historical Climatology Series 4-1* (temperature, 1931–91), *4-2* (precipitation, 1931–91), *5-1* (heating degree days, 1931–92), and *5-2* (cooling degree days, 1931–91). Atlases of the monthly divisional PDSI, PHDI, and Z-index values from January 1895 to December 1983 have been published in the publications *Historical Climatology Series 3-6* to *3-11.*

The historical divisional monthly data (temperature, precipitation, and the four Palmer drought indexes) for the contiguous 48 states are available digitally in the TD-9640 dataset. This dataset includes values beginning in January 1895 and ending approximately 5 months prior to the current calendar month. The historical statewide monthly data (temperature, precipitation, and heating and cooling degree days) from the period 1931–91 are available digitally in the TD-9641 dataset.

(a)



(b)

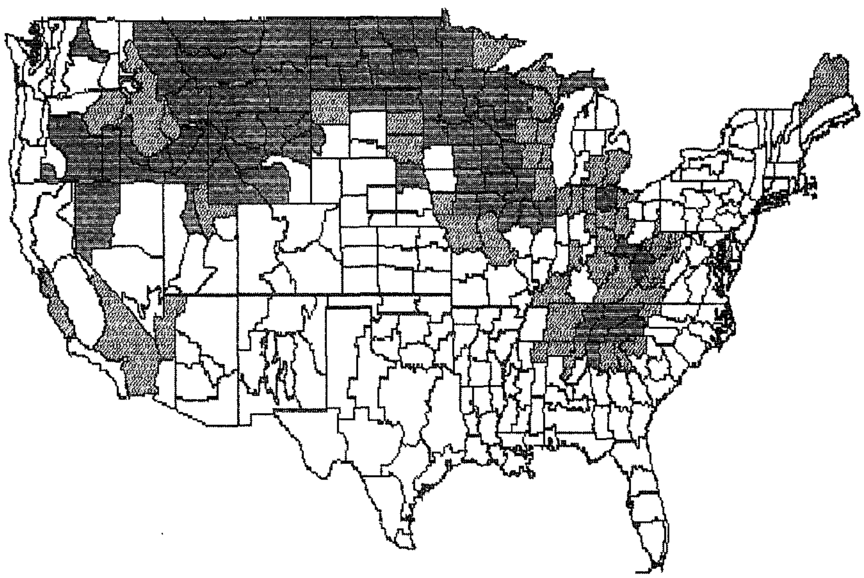


FIG. 4. Moisture anomaly (PDSI) maps of (a) July 1934, the height of the dust bowl era; and (b) July 1988, the driest month in the 1988 drought. Dark areas indicate extreme conditions, and grey areas indicate severe conditions.

The preliminary divisional temperature, precipitation, and Palmer index values that are used in the *Climate Variations Bulletin* are available digitally as part of the NCDC's On-line Access Service Information System (OASIS). The OASIS system uses on-line access via the Internet (address: 192.67.134.72; login: storm; password: research). This divisional dataset is located in the surface data category of OASIS.

Further information about these products can be obtained by calling (704) 271-4800, or by writing to National Climatic Data Center, NOAA, Federal Building, 151 Patton Avenue, Room 120, Asheville, NC 28801-5001; Internet: ORDERS@ncdc.noaa.gov; WWW: http://www.ncdc.noaa.gov/.

7. Conclusions

The history of climatic divisions in the contiguous United States has been pieced together from fragmentary documentation. Divisional boundaries are now

(c)

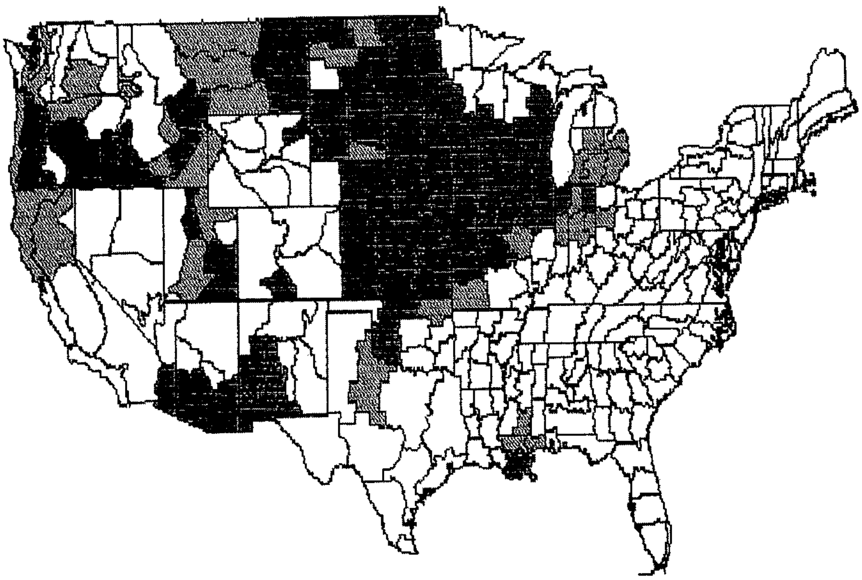


FIG. 4c. As in Figs. 4a and b but for July 1993, the extreme wet spell of 1993 resulting in the catastrophic floods of that year.

standardized, and a dataset of climatic variables for time-invariant divisional boundaries has been compiled for the period of record beginning in 1895. Despite some weaknesses, the dataset has proven to be useful for putting anomalous meso- and macroscale weather events into historical perspective. It is also useful in climatic research and applications concerning major economic sectors such as energy, agriculture, and water resources.

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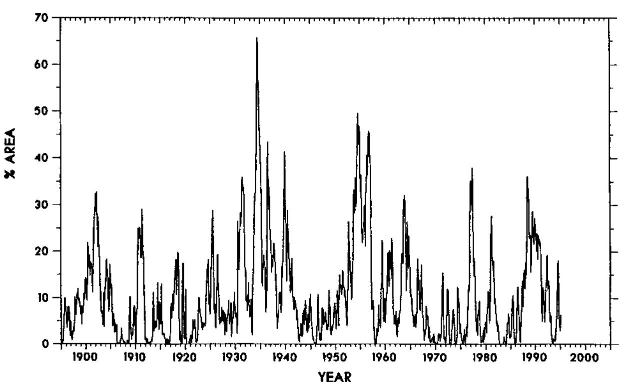

FIG. 5. Percent area of the contiguous United States experiencing severe to extreme long-term drought (PDSI −3.0 or lower) from January 1895 to March 1995, based on climatic division data.

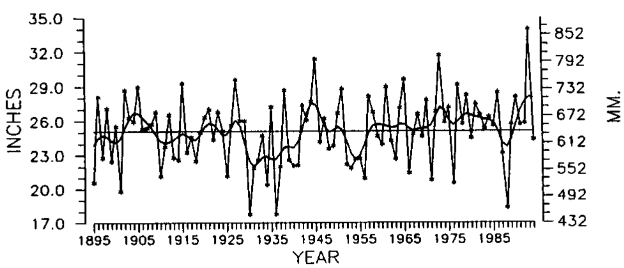

FIG. 6. Growing season (March–September) precipitation averaged across the primary corn and soybean agricultural region, 1895–1994. The darker smooth curve is a nine-point binomial filter that averages the year-to-year fluctuations and shows the longer-term variations.

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